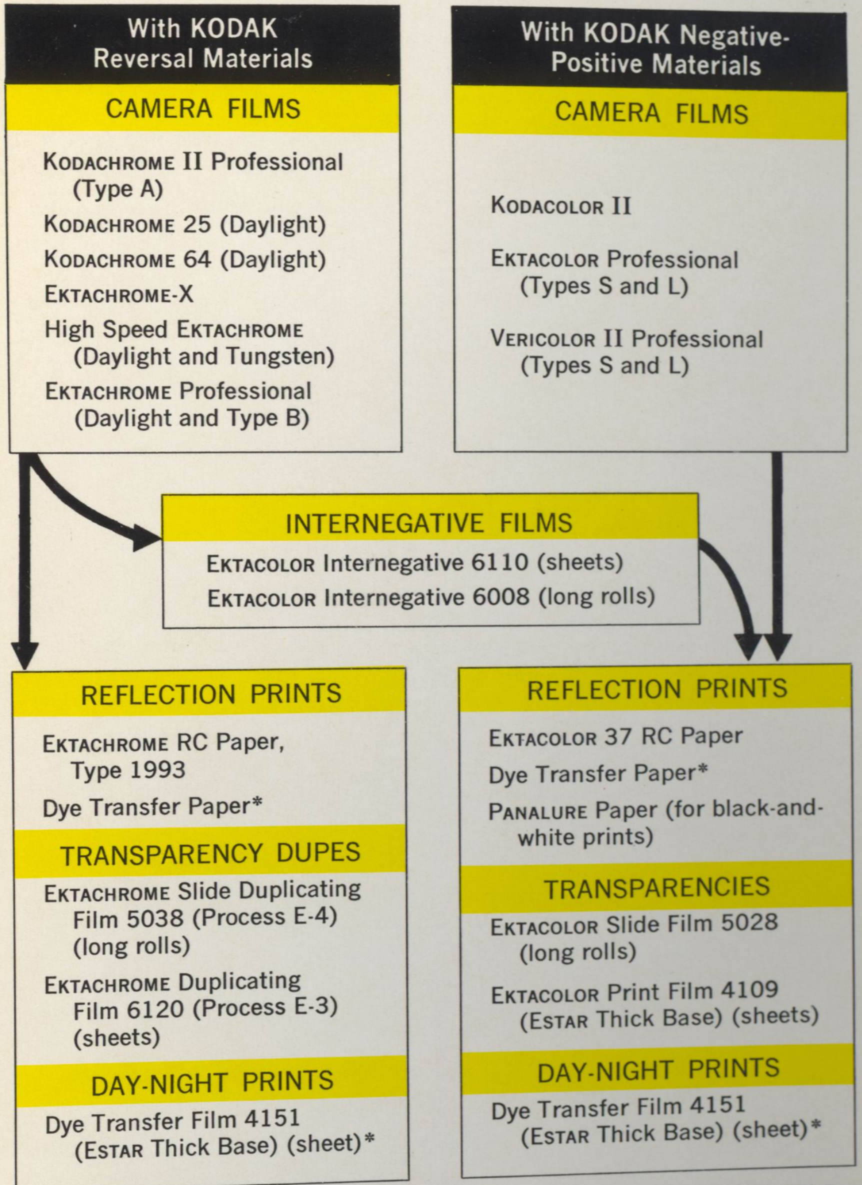
PATHWAYS TO COLOR



With KODAK Reversal Materials

CAMERA FILMS

- KODACHROME II Professional (Type A)
- KODACHROME 25 (Daylight)
- KODACHROME 64 (Daylight)
- EKTACHROME-X
- High Speed EKTACHROME (Daylight and Tungsten)
- EKTACHROME Professional (Daylight and Type B)

With KODAK Negative-Positive Materials

CAMERA FILMS

- KODACOLOR II
- EKTACOLOR Professional (Types S and L)
- VERICOLOR II Professional (Types S and L)

INTERNEGATIVE FILMS

- EKTACOLOR Internegative 6110 (sheets)
- EKTACOLOR Internegative 6008 (long rolls)

REFLECTION PRINTS

- EKTACHROME RC Paper, Type 1993
- Dye Transfer Paper*

TRANSPARENCY DUPES

- EKTACHROME Slide Duplicating Film 5038 (Process E-4) (long rolls)
- EKTACHROME Duplicating Film 6120 (Process E-3) (sheets)

DAY-NIGHT PRINTS

- Dye Transfer Film 4151 (ESTAR Thick Base) (sheet)*

REFLECTION PRINTS

- EKTACOLOR 37 RC Paper
- Dye Transfer Paper*
- PANALURE Paper (for black-and-white prints)

TRANSPARENCIES

- EKTACOLOR Slide Film 5028 (long rolls)
- EKTACOLOR Print Film 4109 (ESTAR Thick Base) (sheets)

DAY-NIGHT PRINTS

- Dye Transfer Film 4151 (ESTAR Thick Base) (sheet)*

*Printing from transparencies requires color-separation negatives on KODAK SUPER-XX Pan Film 4142 (ESTAR Thick Base) and matrices on KODAK Matrix Film 4150 (ESTAR Thick Base), or equivalent. Printing from color negatives requires matrices on KODAK Pan Matrix Film 4149 (ESTAR Thick Base), or equivalent. Prints on KODAK Dye Transfer Film 4151 can be viewed by either reflected light or a combination of reflected and transmitted light.

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EXPOSING

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FILMS DATA
EXPOSURE CORRECTIONS
FILTERS
GRAY CARD GRAY SCALE
PROCESSING DATA
PROCESS STEPS
REPLENISHMENT
CAPACITIES
FILTER CHART
VIEWING FILTERS
FILTER COMPUTER
PRINT COMPUTER

The series of KODAK WRATTEN Filters known as KODAK Light Balancing Filters can be used to change the color quality of the exposing light in order to secure proper color balance with artificial-light films.

KODAK Light Balancing Filters

Color	Filter Number	Exposure Increase in Stops*	Color Temperature of Source		Mired Interval
			Converted to 3200 K	Converted to 3400 K	
Bluish	82C + 82C	1⅓	2490 K	2610 K	−89
	82C + 82B	1⅓	2570 K	2700 K	−77
	82C + 82A	1	2650 K	2780 K	−65
	82C + 82	1	2720 K	2870 K	−55
	82C	⅔	2800 K	2950 K	−45
	82B	⅔	2900 K	3060 K	−32
	82A	⅓	3000 K	3180 K	−21
	82	⅓	3100 K	3290 K	−10
No Filter Necessary			3200 K	3400 K	—
Yellowish	81	⅓	3300 K	3510 K	9
	81A	⅓	3400 K	3630 K	18
	81B	⅓	3500 K	3740 K	27
	81C	⅓	3600 K	3850 K	35
	81D	⅔	3700 K	3970 K	42
	81EF	⅔	3850 K	4140 K	52

The KODAK Color Compensating Filters listed below are used to make changes in the overall color balance of photographic results obtained with color films and to compensate for deficiencies in the quality of the light by which color films must sometimes be exposed. Over camera and enlarger lenses, they can be used singly, or in combinations of no more than three filters, to introduce almost any desired correction.

KODAK Color Compensating Filters

Peak Density	Yellow (Absorbs Blue)	Exposure Increase in Stops*	Magenta (Absorbs Green)	Exposure Increase in Stops*	Cyan‡ (Absorbs Red)	Exposure Increase in Stops*
.025	CC025Y	—	CC025M	—	CC025C	—
.05	CC05Y†	—	CC05M†	⅓	CC05C†	⅓
.10	CC10Y†	⅓	CC10M†	⅓	CC10C†	⅓
.20	CC20Y†	⅓	CC20M†	⅓	CC20C†	⅓
.30	CC30Y	⅓	CC30M	⅔	CC30C	⅔
.40	CC40Y†	⅓	CC40M†	⅔	CC40C†	⅔
.50	CC50Y	⅔	CC50M	⅔	CC50C	1
Peak Density	**Red (Absorbs Blue and Green)**	**Exposure Increase in Stops***	**Green (Absorbs Blue and Red)**	**Exposure Increase in Stops***	**Blue (Absorbs Red and Green)**	**Exposure Increase in Stops***
.025	CC025R	—	—	—	—	—
.05	CC05R†	⅓	CC05G	⅓	CC05B	⅓
.10	CC10R†	⅓	CC10G	⅓	CC10B	⅓
.20	CC20R†	⅓	CC20G	⅓	CC20B	⅔
.30	CC30R	⅔	CC30G	⅔	CC30B	⅔
.40	CC40R†	⅔	CC40G	⅔	CC40B	1
.50	CC50R	1	CC50G	1	CC50B	1⅓

*These values are approximate. For critical work, they should be checked by practical test, especially if more than one filter is used.

†Similar KODAK Color Printing Filters (Acetate) are available. They should be used only between the light source and the negative.

‡Another series of cyan color-compensating filters, designated with the suffix "—2," is recommended for use in EKTACOLOR and EKTACHROME Paper printing filter packs.

Other KODAK Filters and Their Uses

KODAK Filter Number	Use	Exposure Increase
1A (Skylight)	Reduces bluishness in outdoor pictures	None
80A (3200 K)	Balances 3200 K for daylight-type films	2 stops
80B (Photoflood)	Balances 3400 K for daylight-type films	1⅔ stops
80C (Photoflash)	Balances aluminum-filled clear flash (M2, 5, 25) for daylight-type films	1 stop
80D (Photoflash)	Balances zirconium-filled clear flash (AG-1, M3) for daylight-type films	⅓ stop
85 (Daylight)	Balances daylight for Type A film	⅔ stop
85B (Daylight)	Balances daylight for Type B and Type L films	⅔ stop

USING THE GRAY CARD, SCALE, AND COLOR PATCHES

When placed prominently in the scene so that they receive the same illumination as the subject, the next two pages provide useful information for color-negative photography and color printing. The large neutral 18 percent reflectance gray area becomes an ideal reference area in which to read with either an electronic densitometer or a visual densitometer, as described on page 38, the red, green, and blue densities of a color negative to determine the filter pack and exposure time for printing the negative.

The reproduction of the gray scale in the negative permits a visual evaluation of the exposure. A well-exposed color negative will show differentiation between successive gray patches. The darker patches on page 11 will photograph light on the color negative and will, in an underexposed negative, be indistinguishable from each other, indicating that the negative lacks shadow detail. Similarly, the lighter patches on page 11 will, in an overexposed negative, be of the same dark tone, indicating that the negative lacks highlight detail.

The color patches on page 11 can be compared with their appearance on the test print to ascertain the faithfulness of color reproduction. Poor color balance in the test print can then be corrected by adding or subtracting filters from the printing filter pack as described in the Printing section of this Dataguide.

Besides its use as a reference area in printing, the neutral gray card, when used with a reflected-light exposure meter, is helpful in determining exposure in either artificial light or daylight, in adjusting the lighting ratio for studio photography, and in checking the lighting distribution on indoor subjects. To determine the exposure indoors, hold the card close to and in front of the subject, turning the card so that it faces halfway between the camera and the main light; then take the light reading from the card, with the meter not more than 6 inches away. Do not allow your shadow or that of the meter to affect the reading. To determine the exposure outdoors, hold the card straight up and down, so that it faces halfway between the sun and the camera, and take the light reading from the card. For a front-lighted subject, give ½ stop more exposure than is indicated by the computer dial of the meter.

GRAY CARD
GRAY SCALE
PROCESSING DATA AND STEPS
CAPACITIES, REPLENISHMENT
FILTER CHART
VIEWING FILTERS
FILTER COMPUTER
PRINT COMPUTER

TABLE I. STARTING FILTER PACKS

Negatives	Tungsten-Halogen Lamps		212 or 302 Lamps CC or CP Filters
	Dichroic Filters	CC or CP Filters	
Vericolor II Prof.	60M + 100Y	80M + 90Y	80M + 60Y
Kodacolor II	60M + 120Y	80M + 110Y	80M + 80Y
Ektacolor Prof.	30M + 80Y	50M + 70Y	50M + 40Y
Kodacolor-X	30M + 60Y	50M + 50Y	50M + 20Y

TABLE II. FILTER PACK ADJUSTMENTS

If Test Print Is:	Amount of Change Desired		
	Very Slight	Slight	Considerable
TOO RED	add 05M & 05Y	add 10M & 10Y	add 20M & 20Y
TOO GREEN	subtract 05M / or add 05C-2 & 05Y	subtract 10M / or add 10C-2 & 10Y	subtract 20M / or add 20C-2 & 20Y
TOO BLUE	subtract 05Y / or add 05C-2 & 05M	subtract 10Y / or add 10C-2 & 10M	subtract 20Y / or add 20C-2 & 20M
TOO CYAN	subtract 05M & 05Y / or add 05C-2	subtract 10M & 10Y / or add 10C-2	subtract 20M & 20Y / or add 20C-2
TOO MAGENTA	add 05M	add 10M	add 20M
TOO YELLOW	add 05Y	add 10Y	add 20Y

IDENTIFYING NEGATIVES ON *KODAK* FILMS

Film	Color of		
	D-min	Edge Print	Stripes
Vericolor II	light tan	neutral; ● after frame No.	magenta on 135 size
Kodacolor II	light tan	neutral; ■ after frame No.	green on 135, 126
Ektacolor	orange	magenta	(no stripes)
Kodacolor-X	orange	green on 135 size	(no stripes)

1974

Enlarger: Use an enlarger designed for making color prints. Other enlargers can be used if fitted with a heat-absorbing glass, a tungsten lamp (such as a Photo Enlarger No. 212 or 302), and a 2B filter (such as a Kodak Filter No. 2B or CP2B) placed above the negative carrier.

Safelight: Kodak Safelight Filter, No. 13 (amber) or No. 10 (dark amber). You can see better in the darkroom with a No. 13 filter.

Filters Required: Individual color printing filters are not necessary if your color enlarger has dial-in dichroic filters. When color printing filters are needed, use Kodak Color Compensating Filters (CC), or equivalent, if they must be placed between the negative and the printing paper. Use acetate filters such as Kodak Color Printing Filters (CP), or equivalent, if they are to be placed between the enlarger lamp and the negative.

CC or CP05M
(two) CC or CP10M
CC or CP20M
(two) CC or CP40M

CC or CP05Y
(two) CC or CP10Y
CC or CP20Y
(two) CC or CP40Y

A 40R can be substituted for a permanent 40M plus a 40Y in the basic filter pack.

(Occasionally, CC or CP Filters in the Cyan-2 Series are needed.)

PROCEDURE

1. Place the color negative in the enlarger with the emulsion side toward the lens. Start with the basic filter pack suggested in Table I for the kind of negative being printed. At a 3X magnification, make a test-strip series of three exposures; one for 10 seconds at *f*/8, another for 10 seconds at 1 stop *less* exposure, and another for 10 seconds at 1 stop *more* exposure.

2. Process the Kodak Ektacolor 37 RC Paper. See pages 18 and 19. Dry the print, or view it wet by *transmitted* tungsten light for the proper color appearance.

3. Judge the best density area for color balance. Look at "sensitive" areas such as neutrals or facial tones. Make two decisions: (a) **What color is in excess?** Use the illustrations on pages 29 and 30 as a guide. (b) **How much is that color in excess?** Slightly, considerably, or greatly? The illustrations correspond to a "slight" excess.

4. Apply these decisions about color to Table II, adding or subtracting the filters suggested. Make another print at the lens aperture that gave the proper exposure, adjusting the exposure time according to the instructions on pages 40 and 41.

Example: Suppose the test area that was exposed through CP filters 40M + 10M + 40Y + 10Y for 10 seconds at *f*/8 is best for density but is considerably red. The table indicates the addition of 20M + 20Y to the filter pack. This two-filter increase in the number of filters in the filter pack would require an increase of 3 seconds or a trial exposure time of 13 seconds at *f*/8. If dichroic filters are used, the exposure time adjustment can be ignored.

5. Your next print should be closer to the correct density and color balance. Continue to consult Table II until you obtain the desired result.

FILTER CHART
VIEWING FILTERS
FILTER COMPUTER
PRINT COMPUTER

Enlarger: Use an enlarger designed for making color prints. Other enlargers can be used if fitted with a heat-absorbing glass, a tungsten lamp (such as a Photo Enlarger No. 212 or 302), and a 2B filter (such as a KODAK Filter No. 2B or CP2B) placed above the negative carrier.

Safelight: KODAK Safelight Filter No. 13 (amber) or No. 10 (dark amber). You can see better in the darkroom with a No. 13 filter.

Filters Required: Individual color printing filters are not necessary if your color enlarger has dial-in dichroic filters. When color printing filters are needed, use KODAK Color Compensating Filters (CC), or equivalent, if they must be placed between the negative and the printing paper. Use acetate filters such as KODAK Color Printing Filters (CP), or equivalent, if they are to be placed between the enlarger lamp and the negative.

CC or CP05M	CC or CP05Y
(two) CC or CP10M	(two) CC or CP10Y
CC or CP20M	CC or CP20Y
(two) CC or CP40M	(two) CC or CP40Y

A 40R can be substituted for a permanent 40M plus a 40Y in the basic filter pack.

(Occasionally, CC or CP Filters in the Cyan-2 Series are needed.)

Filters Required for Viewing Prints

The CP or CC filters listed above and the viewing filters on page 35 can be used for viewing test prints. Also, a KODAK Color Print Viewing Filter Kit (R-25) is ideal for the purpose. This kit consists of six 4 x 8-inch viewing filter cards and instructions for use packaged in a vinyl wallet. Each card contains one of the six colors (magenta, red, yellow, green, cyan, and blue) in 10, 20, and 40 density values. Your photo dealer can order a kit for you or you can send an order with a check for $6.95 (plus applicable state and local taxes) to Eastman Kodak Company, Department 454, Rochester, N. Y. 14650.

PROCEDURE

1. Place the color negative in the enlarger with the emulsion side toward the lens. Start with the basic filter pack suggested in Table I for the kind of negative being printed. At a 3X magnification, make a test-strip series of three exposures; one for 10 seconds at $f/8$, another for 10 seconds at 1 stop *less* exposure, and another for 10 seconds at 1 stop *more* exposure.

2. Process and dry the paper and note the best exposure.

3. Under the same type of illumination as will be used to view the final print, judge the best exposed area for color balance by looking at it through the viewing filters. Follow the directions on pages 35 and 36 to determine the modified filter pack.

4. Using one of the methods on pages 40 and 41, determine the new exposure time for the next print.

Use these viewing filters to determine which color makes the test print look best. Look at the lighter middle tones in the print by holding the filter away from the print so that the light falling on the print does not go through the filter first. If this does not produce sufficient correction, lay the filter down on the print. This approximately doubles the effective density of each of the filters at right. The amount of correction in the particular color needed can be estimated in the following manner:

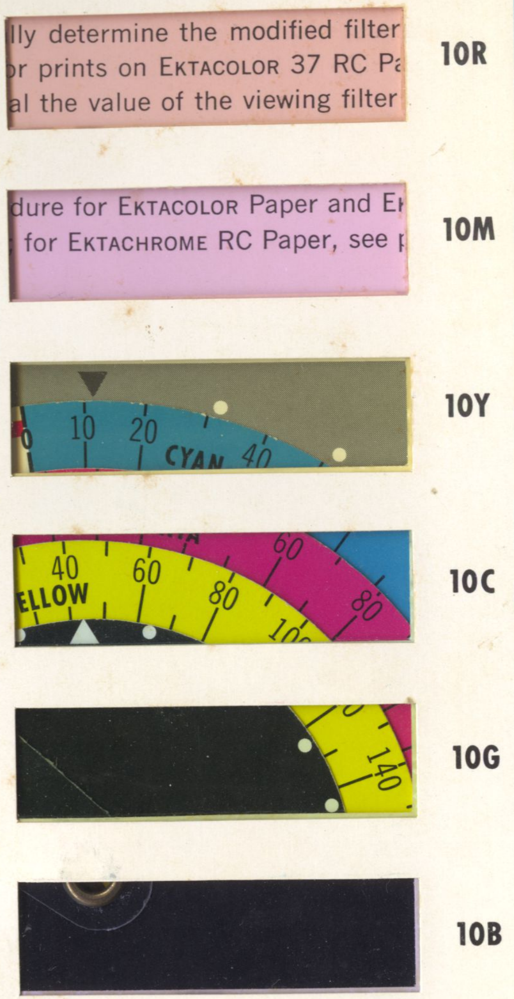
05 filtration if the filter overcorrects when held away from the print.

10 filtration if the filter properly corrects when held away from the print.

15 filtration if the filter undercorrects when held away from the print or overcorrects when placed on print.

20 filtration if the filter properly corrects when placed on the print.

30 filtration if the filter undercorrects when placed on the print.



When you have determined the viewing filter(s) that make the test print look best, use the CC Filter Computer on page 37 to find the simplest new filter pack for the next print. Directions for use are on page 36. (You don't need to use the filter computer if you follow these rules for printing negatives: "Add to the filter pack a filter that is ½ in value and complementary in color to the viewing filter. If the filter to be added is a cool color such as G, B, or C, then instead of *adding* that filter to the pack, *remove* its complement from the filter pack." *Example:* If the viewing filter was a 10R, you would add an 05C to the pack. But since 05C is a cool color, remove an 05R from the pack. Since 05R is equivalent to 05M + 05Y, and most likely part of the filter pack, you would remove 05M + 05Y.)

VIEWING FILTERS
FILTER COMPUTER
PRINT COMPUTER

Enlarger: Use an enlarger designed for making color prints. Other enlargers can be used if fitted with a heat-absorbing glass, a tungsten lamp (such as a Photo Enlarger No. 212 or 302), and a 2B filter (such as a KODAK Filter No. 2B or CP2B) placed above the negative carrier.

Safelight: KODAK Safelight Filter No. 13 (amber) or No. 10 (dark amber). You can see better in the darkroom with a No. 13 filter.

Filters Required: Individual color printing filters are not necessary if your color enlarger has dial-in dichroic filters. When color printing filters are needed, use KODAK Color Compensating Filters (CC), or equivalent, if they must be placed between the negative and the printing paper. Use acetate filters such as KODAK Color Printing Filters (CP), or equivalent, if they are to be placed between the enlarger lamp and the negative.

Equipment for Negative Evaluation: KODAK Color Densitometer, Model 1

PROCEDURE

Test Printing

1. Follow the procedure for either Color-Printing Method No. 1 or No. 2, and make a satisfactory print from the standard negative included in this Dataguide or one of your own typical negatives. If you use your own negative, it should include a suitable reference area — such as a neutral gray card, or a medium-tone flesh image, or a white card — which is common to all the negatives you intend to print.
2. Record the filter pack, exposure time, lens opening, and magnification used to make the good print.

Determining the Filter Pack

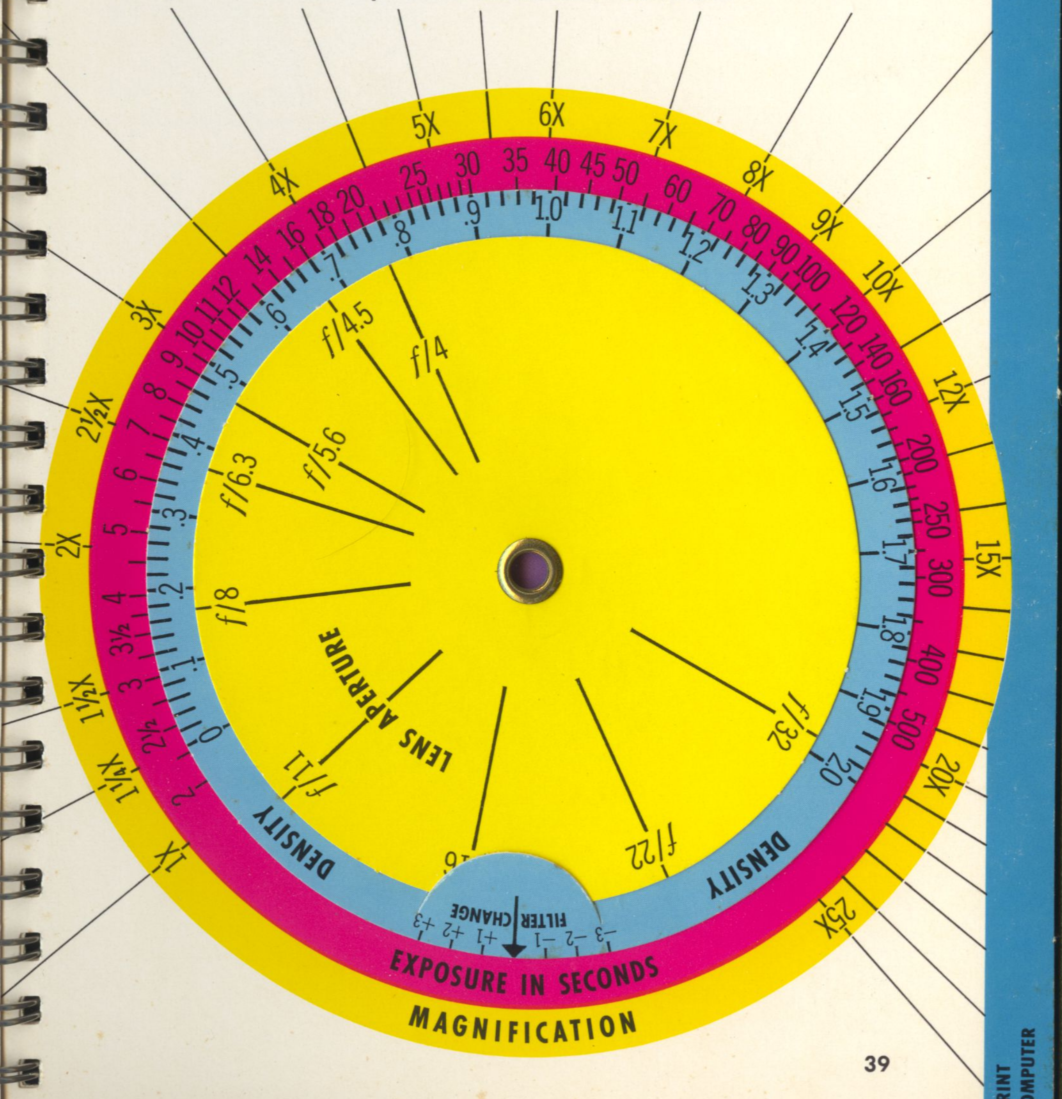
1. On the KODAK Color Densitometer, read the red, green, and blue densities of the selected reference area in the standard negative:
2. Enter the filter pack used to print the standard negative. (In the example at right, the filter pack is 50M + 70Y. Translate any red filter into yellow and magenta filters; e.g., 50R = 50M + 50Y):
3. Add steps 1 and 2:
4. Subtract each of the smaller two figures in step 3 from the largest one and enter the differences in the two appropriate columns:
5. Read the red, green, and blue densities of the selected reference area in the new negative:
6. Add steps 4 and 5:
7. Subtract each of the smaller two figures in step 6 from the largest one and enter the differences in the two appropriate columns:
8. Filter pack for the new negative:

EXAMPLE:

R 1.10	G 1.20	B 1.30
C	M 0.50	Y 0.70
1.10	1.70	2.00
0.90	0.30	
R 0.95	G 1.00	B 1.20
1.85	1.30	1.20
C	M 0.55	Y 0.65
	55M + 65Y	

Color-Printing Method No. 3 cont'd on page 40.

This computer relates the five variables: exposure, density, lens aperture, magnification, and exposure changes for filters. Use of the exposure, density, lens-aperture, and magnification scales is described at the top of page 40. Instructions for using the "Filter Change" scale appear at the bottom half of page 40. Notice that in order to use the lens-aperture and magnification scales, it is necessary to line up the desired lens-opening and magnification combination by sighting across the density and exposure-time scales. Long radial lines have been incorporated on the computer to facilitate this operation. **The exposure-time dial includes reciprocity effect compensation for KODAK EKTACOLOR 37 RC Paper, EKTACHROME RC Paper, PANALURE Paper, and EKTACOLOR Print Film.**



Determining the Exposure Time

1. On the computer on page 39, set the red-filter density of the reference area in the standard negative opposite the exposure time used to print the standard negative.

2. Hold the Density dial and rotate the Lens Aperture dial so that the f-number and magnification used to print the standard negative come together. To perform the operations in the following steps, manipulate these two dials as one.

3. With the standard-negative red-filter density opposite the standard-negative exposure time, read the exposure time for the new negative opposite the red-filter density of the reference area in the new negative.*

4. If you want to change either the magnification or the lens opening, rotate the two locked dials to bring together the desired magnification and lens opening. Read the exposure time opposite the red-filter density of the new negative.*

5. If you want to change the exposure time, rotate the two locked dials to bring the red-filter density of the new negative opposite the desired exposure time. Now expose the new negative at one of the lens aperture-magnification combinations appearing on the computer.*

*If the standard-negative filter pack is changed to print the new negative, this filter change may necessitate an exposure adjustment. See procedure below.

Finding Exposure Change for a Filter Change

An exposure time which produced a print of satisfactory density may not produce the same density when the printing filter pack is changed. Use the computer on page 39 to find the new exposure time as follows:

Color-Printing Method No. 3: Set the arrow on the filter-change dial opposite the exposure time to be used to print the new negative. Count the number of filters in the filter pack used to print the standard negative and the number to be used in the new filter pack. If one filter has been added to the new pack, read the new exposure time opposite +1; if two filters have been added, read the new time opposite +2; etc. If one filter has been subtracted from the new pack, read the new exposure time opposite −1; etc.

Color-Printing Methods No. 1 and No. 2: If the color of the test print is considerably out of balance (say, by a 30 or more filter strength), the density is difficult to evaluate, and using the following procedure to change the exposure time for a filter change is meaningless. However, if the test print is relatively close to the desired color balance (say, by a 10 or 20 filter strength), the density of the test strips can be evaluated successfully and the following procedure applied.

Set the arrow on the filter-change dial opposite the test-print exposure time. Count the number of filters in the test-print filter pack and the number to be used in the new filter pack. If one filter has been added to the new pack, read the new exposure time opposite +1; if two filters have been added, read the new time opposite +2; etc. If one filter has been subtracted from the new pack, read the new exposure time opposite −1; etc.

An exposure time that produced a print of satisfactory density may not produce the same density when the printing filter pack used for white-light printing is changed. The new exposure time can be found by either of two procedures, depending upon which of the following methods is used to judge color prints.

1. In printing color negatives, some workers think of exposure time as controlling density and the filter combination as controlling color balance. They, therefore, judge the over-all apparent density and color balance of a print. Whenever the filter pack is changed, allowance should be made for the change in exposure introduced by (1) the change in filtering action, and (2) the change, if any, in the number of filter surfaces. The following table provides methods of determining such exposure adjustments. Both the computer numbers and the filter factors include allowance for the loss of light caused by reflections from the filter surfaces.

If the pack is changed by only one filter, use of the appropriate filter factor is convenient. Otherwise, the use of the computer numbers with the Color-Printing Computer on page 39 will probably be preferred.

Computer Numbers and Factors for KODAK CC and CP Filters

Filter	Computer No.	Factor	Filter	Computer No.	Factor
05Y	.04	1.1	05R	.07	1.2
10Y	.04	1.1	10R	.10	1.3
20Y	.04	1.1	20R	.17	1.5
30Y	.05	1.1	30R	.23	1.7
40Y	.05	1.1	40R	.29	1.9
50Y	.05	1.1	50R	.34	2.2
05M	.07	1.2	05G	.06	1.1
10M	.10	1.3	10G	.08	1.2
20M	.16	1.5	20G	.12	1.3
30M	.22	1.7	30G	.15	1.4
40M	.27	1.9	40G	.18	1.5
50M	.32	2.1	50G	.22	1.7
05C	.06	1.1	05B	.04	1.1
10C	.08	1.2	10B	.12	1.3
20C	.12	1.3	20B	.21	1.6
30C	.15	1.4	30B	.29	2.0
40C	.18	1.5	40B	.38	2.4
50C	.21	1.6	50B	.47	2.9

To use computer numbers: Add the computer-number values for all the filters in the old pack. On the "Density" scale of the Color-Printing Computer, set the sum of the computer numbers so that it is opposite the exposure time used. Read the new exposure time opposite the sum of the computer numbers for the new pack.

To use factors: First divide the old exposure time by the factor* for any filter removed from the pack. Then multiply the resulting time by the factor* for any filter added.

*For two or more filters, multiply the individual factors together and use the product.

2. Experienced workers consider test prints in terms of the three separate layers. Thus, they keep in mind the fact that a change in exposure affects all three dye images, and they mentally take apart the test print and consider what needs to be done to each layer. If color prints are evaluated in this way, the exposure change for a filter-pack change need allow only for the change in the number of filter surfaces. Compute the exposure change by using the procedure described on page 40.

PRINTING ON *KODAK EKTACOLOR* PRINT FILM 4109 (*ESTAR* THICK BASE)

Exposures on Ektacolor Print Film can be made either by contact or by projection. The light source for either contact or enlarged printing must be equipped with heat-absorbing glass and a Kodak Wratten Filter No. 2B or Color Printing Filter CP2B (Acetate). Either Kodak Color Compensating (CC) Filters or Kodak Color Printing (CP) Filters can be used to control the color of the exposing light. Any number of CC or CP Filters can be used if they are placed between the light source and the color negative; only CC Filters are usable between the negative and the print film, and their number should not exceed three if definition is of major importance. Dichroic filters can also be used.

Color-Printing Method No. 1, 2, or 3 can be used to make transparencies on Ektacolor Print Film. Merely substitute Ektacolor Print Film for the Ektacolor Paper, and, instead of using 50M + 50Y as a starting filter pack, use the filter pack recommendation on the instruction sheet packed with the film. This suggested filter pack applies, of course, to specific equipment. Make test prints until you obtain a satisfactory transparency. The difference between the filter pack you used to obtain a good transparency and that suggested on the instruction sheet can be regarded as a filter correction for your equipment. That difference can be added to the filter suggestion for other Ektacolor Print Film emulsions to obtain a starting filter pack for new emulsions.

Ektacolor Print Film is exposed with its emulsion side facing the emulsion of the color negative and with a sheet of black interleaving paper behind the print film.

PRINTING ON *KODAK PANALURE* PAPER

Kodak Panalure and Panalure Portrait Papers are designed to produce, from color negatives, black-and-white prints with a tone rendering similar to that of prints made from negatives on panchromatic film. Expose the paper without filters to a tungsten lamp, such as a Photo Enlarger No. 212 or 302. The enlarger or contact-printing light source should be equipped with heat-absorbing glass.

For results other than the usual panchromatic rendering, use Kodak Color Compensating (CC) Filters. To lighten a subject color, use a filter of the subject color in the enlarger; to darken a subject color, use a complementary color filter. For example, to darken reds, use two CC50C filters in the light beam.

Panalure Paper can be handled by the light of a Kodak Safelight Filter No. 10 (dark amber) or a No. 13 (amber), used in a suitable safelight lamp with a 7½-watt bulb, kept at least 4 feet from the paper. Since the paper is sensitive to all colors of light, keep exposure to the safelight at a minimum until after the paper has been in the developer at least 30 seconds.

Process the paper in Kodak Dektol Developer or Kodak Developer D-72, both diluted 1:2. Develop with continuous agitation about 1½ minutes at 68 F (20 C). The useful range of developing time is between 1 and 3 minutes.

Kodak Selectol Developer diluted 1:1 can also be used. To obtain lower contrast, use Kodak Selectol-Soft Developer diluted 1:1.

Develop with continuous agitation about 2 minutes at 20 C (68 F).

Handle the prints face up during development and agitate them thoroughly, keeping them under the solution as much as possible.

Rinse, fix, wash, and dry as with other black-and-white prints.

PRINTING ON *KODAK EKTACHROME* RC PAPER

Kodak Ektachrome RC Paper can be used for making color prints with a single exposure from Kodachrome and Ektachrome transparencies. The paper should be handled only in total darkness. The exposing light source should be equipped with a Kodak Infrared Cutoff Filter No. 301 and an ultraviolet absorber, such as the Kodak Wratten Filter No. 2E. Expose the paper to a tungsten lamp, such as a Photo Enlarger No. 212 or 302, and control the color of the exposing light with either Kodak Color Compensating (CC) or Kodak Color Printing (CP) Filters (Acetate). Any number of CC or CP Filters can be used if they are placed between the light source and the color transparency; only CC Filters are usable between the transparency and the printing paper, and their number should not exceed three if definition is of major importance.

If, for example, the enlarger is set up with a Photo Enlarger Lamp No. 212, a filter pack of 25M + 10Y, an *f*/4.5 lens opening, and an enlargement adjustment to make 5 by 7-inch prints from a 35mm slide, the trial exposure is about 15 seconds. In this example, make exposures at 10, 15, and 25 seconds. Process the print in Kodak Ektaprint R-5 or R-500 Chemicals. Evaluate the color balance using the filters on page 35. Follow these instructions for using the CC Filter Computer.

1. Set all the dials and the swinging arm to 0.
2. View the dried test print through CC Filters to determine those yielding the best appearance to the middletones.
3. Rotate the dial(s) to set the density value(s) of the viewing filter(s) on the appropriate upper scale(s). If two viewing filters of the same color are used, add their densities and set the total value on the appropriate upper scale.
4. (a) Set the swinging arm to the upper blue-yellow zero. Rotate the blue-yellow dial to set the value of any blue or yellow filter used in making the test print.
   (b) Set the swinging arm to the upper green-magenta zero. Rotate the green-magenta dial to set the value of any green or magenta filter used in making the test print.
   (c) Set the swinging arm to the upper red-cyan zero. Rotate the red-cyan dial to set the value of any red or cyan filter used in making the test print.
5. (a) If no two zeros of the three upper dials line up, set the swinging arm at that zero which is between the other two. At the point where the arm crosses the other two dials, read the values of the filters required in the new filter pack.
   (b) If two zeros line up, set the arm there. At the point where the arm crosses the other dial, read the value of the filter required in the new pack.
   (c) If all three zeros line up, no filters are needed.

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Filters

Color Temperature

Films used in color photography are usually designed for use with a particular light source at a specified color temperature.

Film Type	Light Source
Daylight, Type S	5500 K
Type A	3400 K
Tungsten, Type L	3200 K

Color temperatures are measured in degrees Kelvin. A light source with a high color temperature is bluish; a light source with a low color temperature is yellowish red. Only light sources which emit a continuous spectrum, such as electronic flash, flashbulbs, and filament lamps can have light output measured in terms of color temperature. For other light sources, such as fluorescent tubes, see pages 8 and 19.

Practical Sources of Illumination and their Approximate Color Temperatures

Source	Color Temperature (K)
Skylight	12000 to 18000
Overcast sky	7000
Photographic daylight	5500
Flash (electronic, bulbs, cubes)	5500
White-flame carbon arc	5000
500-watt 3400 K photolamp (approx. 27.0 lumens/watt)	3400
500-watt 3200 K tungsten lamp (approx 27.0 lumens/watt)	3200
200-watt general service (approx 20.0 lumens/watt)	2980
100-watt general service (approx 17.5 lumens/watt)	2900
75-watt general service (approx 15.4 lumens/watt)	2820
40-watt general service (approx 11.8 lumens/watt)	2650

Color Compensating (CC) Filters

Used in image-forming systems to change the overall color balance for exposing, viewing, or printing.

	Stops Exposure Increase (Filter Factor)					
Filter Value	Yellow	Magenta	Red	Cyan	Green	Blue
05	None (1.0)	⅓ (1.2)	⅓ (1.2)	⅓ (1.1)	⅓ (1.1)	⅓ (1.1)
10	⅓ (1.1)	⅓ (1.3)	⅓ (1.3)	⅓ (1.2)	⅓ (1.2)	⅓ (1.3)
20	⅓ (1.1)	⅓ (1.5)	⅓ (1.5)	⅓ (1.3)	⅓ (1.3)	⅔ (1.6)
30	⅓ (1.1)	⅔ (1.7)	⅔ (1.7)	⅔ (1.4)	⅔ (1.4)	⅔ (2.0)
40	⅓ (1.1)	⅔ (1.9)	⅔ (1.9)	⅔ (1.5)	⅔ (1.5)	1 (2.4)
50	⅔ (1.1)	⅔ (2.1)	1 (2.2)	1 (1.6)	1 (1.7)	1⅓ (2.9)

Conversion Filters

Kodak Wratten Filter No.		Exposure Increase in Stops	For Changing
85B	Amber filter for exposing Type L (tungsten) color films in daylight	⅔	5500 K to 3200 K
85C	Amber filter used for exposing Type L and tungsten films with electronic flash. Paler than 85B	⅓	5500 K to 3800 K
80A	Blue filter for exposing daylight-type color films in 3200 K tungsten illumination	2	3200 K to 5500 K
80B	Blue filter for exposing daylight-type color films in photolamp 3400 K illumination	1⅔	3400 K to 5500 K

Light-Balancing Filters

May be used over the camera lens to produce subtle changes in the color balance (to a "cooler" or "warmer" appearance) with color films.

Color Temperature Conversions

To Obtain 3200 K from	To Obtain 3400 K from	Wratten Filter	Exposure Increase in Stops	Filter Color
2490 K	2610 K	82C + 82C	1⅓	Bluish
2570 K	2700 K	82C + 82B	1⅓	
2650 K	2780 K	82C + 82A	1	
2720 K	2870 K	82C + 82	1	
2800 K	2950 K	82C	⅔	
2900 K	3060 K	82B	⅔	
3000 K	3180 K	82A	⅓	
3100 K	3290 K	82	⅓	
3300 K	3510 K	81	⅓	Yellowish
3400 K	3630 K	81A	⅓	
3500 K	3740 K	81B	⅓	
3600 K	3850 K	81C	⅔	
3700 K	3970 K	81D	⅔	
3850 K	4140 K	81EF	⅔	

Kodak Wratten Neutral Density Filters No. 96

Density	Percentage Transmission	Filter Factor	Exposure Increase in Stops
0.1	80	1.25	⅓
0.2	63	1.5	⅔
0.3	50	2	1
0.4	40	2.5	1⅓
0.5	32	3	1⅔
0.6	25	4	2
0.7	20	5	2⅓
0.8	16	6	2⅔
0.9	13	8	3
1.0	10	10	3⅓
2.0	1	100	6⅔
3.0	0.1	1000	10
4.0	0.01	10000	13⅓

Films
C-41
Dial
Films
E-6

0M + 90Y

(1980)

KODAK
EKTACOLOR 74 RC and 78 Papers

KODAK EKTACOLOR 74 RC and 78 Papers are fast, resin-coated papers for making color prints from color negatives. These papers can be exposed with conventional enlarging equipment and are designed for processing using KODAK EKTAPRINT 2 Chemicals, or the equivalent.

Surfaces Available

E — Lustre-Luxe surface. Fine-grained, lustrous surface.
F — smooth, glossy surface, dries to a high gloss without ferrotyping
N — smooth, matte surface
Y — silk surface

Storage

High temperature or high humidity may produce undesirable changes in KODAK EKTACOLOR Paper. Keep unexposed paper at 50°F (10°C) or lower in the original sealed package. Carefully reclose the bag, pressing out the excess air, after removing the paper to be exposed.

To avoid moisture condensation on unexposed paper which has been refrigerated, allow paper to warm up to room temperature before opening the sealed bag. *For best results, remove unexposed paper from cold storage the day before printing;* otherwise, use the warm-up times below.

Warm-up Times for KODAK EKTACOLOR Paper

Paper size	From 0 to 70°F (−18 to 21°C)	From 35 to 70°F (1.5 to 21°C)	From 50 to 70°F (10 to 21°C)
8 x 10-inch (100-sheet box)	4 hours	3 hours	2 hours
16 x 20-inch (50-sheet box)	3 hours	2 hours	2 hours

Safelight

Use a KODAK Safelight Filter No. 13 (amber) with a 7½-watt bulb in a safelight lamp at a distance of at least 4 feet. After exposure, the paper can be handled for no longer than 3 minutes under the safelight. Before exposure, a slightly longer safelight exposure can be tolerated, but in either case, safelight exposure should be kept to a minimum.

Starting Filter Pack

If you do not already have a starting filter pack, make a first test print using a filter pack of **50M + 90Y.** To determine the correct exposure time, make a test strip as shown on page 15. Since light quality, optical components, filters, and dial settings vary among different enlargers, this filter pack is intended only as a starting point.

First, adjust the exposure to produce a satisfactory density. Then, if the balance of the resulting print is not satisfactory, try a different filter or combination of filters. Once a good print has been made from a typical negative, the same filter pack can be used for trial exposures with other negatives.

See the wall chart for density and color correction examples.

Test Strips
Proof Prints

Test Strips

To minimize wasted time and materials, many printers expose their first test print as test strips. To do this, set the enlarger lens at *f*/11, cover all but about a 1-inch strip of the paper in the easel, and expose for 5 seconds. Then, without moving the paper, uncover another inch and expose for another 5 seconds. Continue doing this until the entire print is exposed.

After processing, the test print will have several parallel strips of increasing density, each strip having received 5 seconds more exposure than the lighter strip next to it.

Proof Prints

Make proof prints using the filtration and exposure determined by your test prints. (Do not move the enlarger head up or down to make proof prints unless you adjust the exposure time accordingly.) Place your negatives on a sheet of EKTACOLOR Paper, emulsion to emulsion, cover with glass, and expose.

Enlargements made from the negatives you contact-printed will look just like the contact print images (except larger, of course) if you use the same filtration and exposure you used to make the contact prints.

Printing Records

Record exposure data for making acceptable prints here. This information can then be used as starting points for printing with new materials.

- **Prints from negatives**

__________M+__________Y

__________seconds at *f*/__________

Image magnification __________X

Film __________

__________M+__________Y

__________seconds at *f*/__________

Image magnification __________X

Film __________

- **Prints from slides**

__________C+__________M+__________Y

__________seconds at *f*/__________

Image magnification __________X

Film __________

__________C+__________M+__________Y

__________seconds at *f*/__________

Image magnification __________X

Film __________

If emergency information is needed:

Kodak Maintains 24-Hour Poison Information.

The telephone numbers are:

Area Code **(716) 458-1000**

Business hours:	Extension **85566**
After hours and weekends or holidays:	Extension **74755**

KODAK Color Darkroom DATAGUIDE

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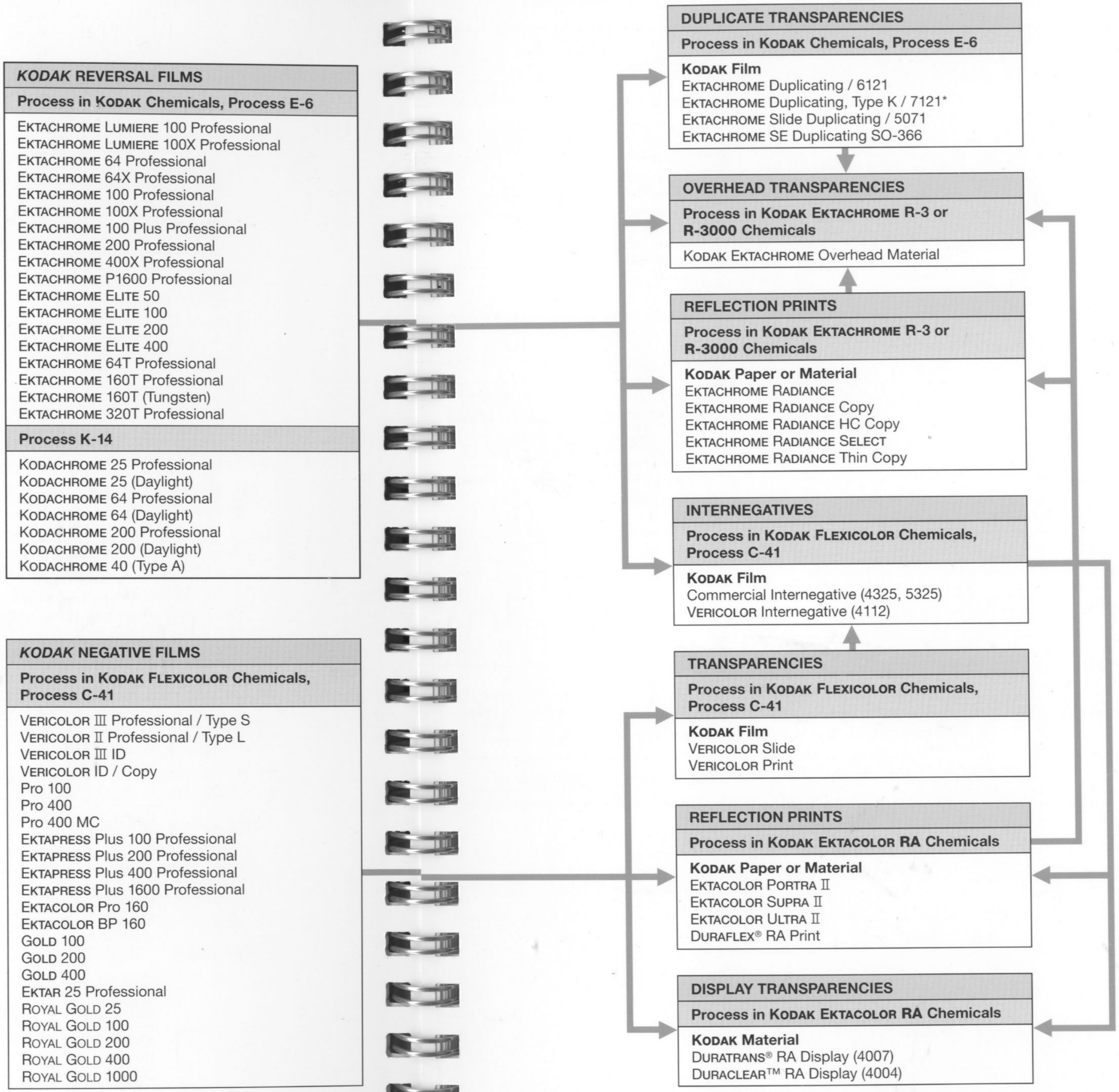
The main purpose of this Dataguide is to provide information on quality color-film and color-print processing and finishing. However, we recognize that top-notch prints and transparencies start with the selection and proper exposure of film designed to produce the best results. Therefore, on the following pages you will find tables and illustrations to help you select a film simply and efficiently.

PATHWAYS TO COLOR

Your pathway to color begins with choosing a color reversal film or a color negative film. If you choose to take your original photograph on a color reversal film, it will be ready for viewing after it is processed. If you use a color negative film, the negatives must be printed on paper or another photographic or electronic output material before you have a positive image that's ready for viewing. Whether you choose a color reversal film or a color negative film depends on your application and preferences.

Professional vs. General-Use Films

Understanding the differences between films with the "professional" designation and those without it is important to professional photographers, photo hobbyists, and everyday picture-takers in choosing the right film for their applications. The professional needs to know that a particular film is near its optimum color balance at the moment it is put into the camera. He or she must be able to measure any slight color or speed bias in a particular film or emulsion and then adjust filtration and exposure to compensate. Kodak professional films are close to optimum color balance when they are manufactured, resulting in a slightly higher cost. Also, most professional films are manufactured for refrigerated storage. Casual picture-takers, on the other hand, usually leave film in the camera for weeks or months before processing and store film at room temperature. In addition, only professional films are supplied in sheets, multiple-roll pro-packs, and long rolls. General-use films are sold as single rolls and as two or three rolls to a package.



KODAK REVERSAL FILMS

Process in Kodak Chemicals, Process E-6

Ektachrome Lumiere 100 Professional
Ektachrome Lumiere 100X Professional
Ektachrome 64 Professional
Ektachrome 64X Professional
Ektachrome 100 Professional
Ektachrome 100X Professional
Ektachrome 100 Plus Professional
Ektachrome 200 Professional
Ektachrome 400X Professional
Ektachrome P1600 Professional
Ektachrome Elite 50
Ektachrome Elite 100
Ektachrome Elite 200
Ektachrome Elite 400
Ektachrome 64T Professional
Ektachrome 160T Professional
Ektachrome 160T (Tungsten)
Ektachrome 320T Professional

Process K-14

Kodachrome 25 Professional
Kodachrome 25 (Daylight)
Kodachrome 64 Professional
Kodachrome 64 (Daylight)
Kodachrome 200 Professional
Kodachrome 200 (Daylight)
Kodachrome 40 (Type A)

KODAK NEGATIVE FILMS

Process in Kodak Flexicolor Chemicals, Process C-41

Vericolor III Professional / Type S
Vericolor II Professional / Type L
Vericolor III ID
Vericolor ID / Copy
Pro 100
Pro 400
Pro 400 MC
Ektapress Plus 100 Professional
Ektapress Plus 200 Professional
Ektapress Plus 400 Professional
Ektapress Plus 1600 Professional
Ektacolor Pro 160
Ektacolor BP 160
Gold 100
Gold 200
Gold 400
Ektar 25 Professional
Royal Gold 25
Royal Gold 100
Royal Gold 200
Royal Gold 400
Royal Gold 1000

DUPLICATE TRANSPARENCIES

Process in Kodak Chemicals, Process E-6

Kodak Film
Ektachrome Duplicating / 6121
Ektachrome Duplicating, Type K / 7121*
Ektachrome Slide Duplicating / 5071
Ektachrome SE Duplicating SO-366

OVERHEAD TRANSPARENCIES

Process in Kodak Ektachrome R-3 or R-3000 Chemicals

Kodak Ektachrome Overhead Material

REFLECTION PRINTS

Process in Kodak Ektachrome R-3 or R-3000 Chemicals

Kodak Paper or Material
Ektachrome Radiance
Ektachrome Radiance Copy
Ektachrome Radiance HC Copy
Ektachrome Radiance Select
Ektachrome Radiance Thin Copy

INTERNEGATIVES

Process in Kodak Flexicolor Chemicals, Process C-41

Kodak Film
Commercial Internegative (4325, 5325)
Vericolor Internegative (4112)

TRANSPARENCIES

Process in Kodak Flexicolor Chemicals, Process C-41

Kodak Film
Vericolor Slide
Vericolor Print

REFLECTION PRINTS

Process in Kodak Ektacolor RA Chemicals

Kodak Paper or Material
Ektacolor Portra II
Ektacolor Supra II
Ektacolor Ultra II
Duraflex® RA Print

DISPLAY TRANSPARENCIES

Process in Kodak Ektacolor RA Chemicals

Kodak Material
Duratrans® RA Display (4007)
Duraclear™ RA Display (4004)

*For duplicating originals on Kodachrome Film.

MAKING COLOR PRINTS AND OTHER LAB IMAGES

This section discusses the materials, equipment, procedures, and processes for making prints, duplicate color negatives and transparencies, internegatives, print films, and black-and-white prints from color negatives or transparencies.

PRINTING EQUIPMENT

Enlargers

The enlarger is the most important piece of equipment in color printing. You can use almost any black-and-white enlarger equipped with a filter drawer for color enlarging, except enlargers equipped with fluorescent light sources. However, using an enlarger with a color head that has built-in dichroic filters is easier and more efficient.

Condenser—In a condenser enlarger, usually two condensing lenses are used to focus the light efficiently at the rear element of the enlarger lens. Because they distribute light more efficiently, condenser enlargers normally require shorter exposure times than diffusion enlargers. Condenser enlargers also provide a brighter, sharper, and contrastier image than diffusion enlargers. This can sometimes be a disadvantage, because grain, scratches, dirt, and dust on the negatives show up more readily in the prints.

Diffusion—The light of diffusion enlargers is distributed by diffuse reflection. The lamphouse is usually domed and finished in matte white. Light bounces around the inside of the dome and some of it is diffused downward through the negative and the enlarger lens to the photographic paper. Diffusion heads do not use light as efficiently as condenser enlargers, but they are more efficient at mixing the color-filtered light required for color printing.

Color Head—Enlargers with color heads are diffusion enlargers equipped with intensely bright tungsten-halogen light sources and non-fading dichroic printing filters. The glass filter segments of dichroic filters move in and out of the light beam on carefully calibrated cams that permit accurate control of filter combinations. Color heads shorten printing times and speed production.

Enlargers without color heads require a filter drawer or some other means of holding the filter packs required for color printing. Using filter packs is not as convenient and fast as using a color head, but you can obtain excellent results with them.

Autofocus—With most enlargers, you do two things to control image size and sharpness: move the enlarger head up or down to get the correct image size, and move the lens in relation to the negative to achieve sharp focus. Autofocus enlargers save time by automatically focusing and controlling the image size. Automatic focus is achieved with a cam and levers that simultaneously move the lens and enlarger head into the right position for sharp focus at any magnification.

If your enlarger lamphouse is not equipped with a heat-absorbing glass, be sure to install one. It keeps your filters from fading and protects your negatives or transparencies from excessive heat. You can obtain one from your photo dealer.

Tri-Color (Additive) Printing Systems

Although they're not as popular as the enlargers described above, which use the subtractive system of color printing, some enlargers are designed for an additive system called tri-color printing. Three consecutive exposures are made through red, green, and blue separation filters. Density and color balance of the print are controlled by the amount of exposure the paper receives through each filter.

Enlarging Lenses

To obtain consistently good sharpness, even illumination, and good definition in enlargements, you need a good enlarging lens. Here are some of the requirements of a good lens:

Field Flatness—Because both the original and the paper are held flat during the exposure, a good lens must have a flat field. If a lens does not have a flat field at the magnification you use to make a print, it is difficult to get a sharp image both at the center and at the edges of the image. The field curvature of a lens changes with distance, so a lens can have a truly flat field at only one distance. Stopping down the lens by about two stops from the maximum aperture helps to increase the depth of field and provide sharpness across the image.

Even Illumination—All lenses produce images that are somewhat brighter in the center than at the edges. When the lens is wide open, vignetting makes the drop-off in illumination at the edges more pronounced. This is another good reason for stopping down the lens by one or two stops when you make exposures.

Definition—Lens definition is based on the ability of a lens to form an image, and involves not only resolving power (the number of black-and-white alternate lines the lens can define clearly) but also the degree of contrast in fine detail that it can provide. This is measured as the optical transfer function of the lens. Most lenses produce the best definition when they are stopped down one or two stops from the maximum aperture.

Focal Length—The focal length of a normal enlarging lens should be approximately equal to the diagonal measurement of the negative. Wide-angle lenses have focal lengths that are 20 to 25 percent shorter. At the same enlarger height, a wide-angle lens produces an image about 30 percent larger than a normal lens.

The table below lists the recommended focal lengths for standard negative sizes.

Negative Carriers

Negative carriers are designed to hold negatives reasonably flat and perpendicular to the axis of the enlarger during exposure.

Glassless Negative Carriers—Carriers for small negatives are usually glassless. With a glassless carrier, you need to be sure only that both negative surfaces are dust-free. In most modern enlargers for small-size negatives, a heat-absorbing glass minimizes popping due to excessive heat, and glassless carriers work well for all but the most critical uses.

Negative Carriers with Glass—Negative popping is more of a problem with negatives that are 4 x 5 inches or larger. Carriers that hold the negatives very flat between two pieces of glass are often used with large negatives to provide greater image sharpness. However, you must keep this type of negative carrier extremely clean to prevent trapping dust particles and lint between the glass surfaces.

Easel

The easel holds the paper flat and parallel to the negative at the enlarger base and supplies a surface for sizing and focusing the image. Most easels provide borders on the prints.

Some easels have fixed borders and openings to accommodate standard-size papers. The borders are usually ¼ inch wide. Other easels have adjustable borders for paper of different sizes up to a maximum, such as 16 x 20 inches. Some easels are designed for making borderless prints.

Voltage Regulators

Many enlargers, particularly those with color heads, come equipped with a voltage regulator. A voltage regulator maintains a constant voltage output to the enlarger. Fluctuations in line voltage can cause inconsistencies in density and color balance from print to print. These fluctuations can be caused by appliances, lights, or print dryers being switched on and off. Large motors or elevators in industrial locations or large buildings are likely to cause voltage fluctuations. In some areas, line voltage *to* buildings can fluctuate too.

A 10-percent decrease in line voltage can cause a 30-percent drop in light output and a shift to red or yellow in color prints. Voltage regulators (available from photo dealers and electrical-supply houses) stabilize the voltage to the enlarger even when line voltages fluctuate over a fairly wide range.

Enlarger-Lens Focal Lengths

Negative Format	Focal Length	
	Normal Lens	Wide-Angle Lens
35 mm	50 mm	40 mm
6 x 6 cm	75 to 80 mm	60 mm
6 x 7 cm	100 to 105 mm	80 mm
6 x 9 cm	100 to 105 mm	80 mm
4 x 5 inches	150 to 160 mm	135 mm
5 x 7 inches	8½ inches (210 mm)	—
8 x 10 inches	12 to 14 inches (300 to 360 mm)	—

Filters

The basic difference between black-and-white printing and color printing is that black-and-white printing involves only one silver negative image and one light-sensitive emulsion. In color printing, each of the three dye images in a negative or transparency must be correctly exposed onto each of the three light-sensitive emulsion layers of the print material. You control the correct exposure of these three layers by adjusting the exposure time and the color of the light that reaches the material. In white-light color printing, you adjust the color of the light by placing filters of different colors and saturations into the light beam of the enlarger. These filters modify the light to the specific requirements of the negative or transparency and the print material.

The filters normally used in white-light color printing are color-compensating (CC), color-printing (CP), and dichroic filters.

Kodak Color Compensating (CC) Filters—Because these filters are made of gelatin, you can use them in a holder below the enlarger lens (in the image-forming beam) or between the light source and the negative. If you use them below the lens, any dust, dirt, or fingerprints on the filters will show in the print, so you must handle them very carefully. Also, to avoid degrading the image, use no more than three filters below the lens. The number and density of the filters affect the exposure required for a good print. Therefore, when you change the filter pack, you will need to adjust the exposure time to maintain the correct print density. You can calculate exposure adjustments by using filter factors.

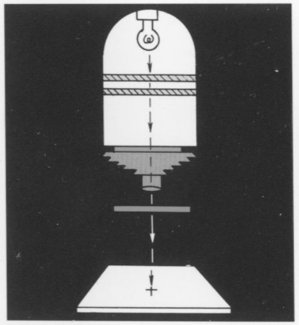
Kodak Color Compensating Filters are available in seven densities (025, 05, 10, 20, 30, 40, and 50) in each of the primary and complementary colors (red, green, blue, cyan, magenta, and yellow).

Kodak Color Printing (CP) Filters—You place these acetate filters between the light source and the negative. Because they are not in the image-forming beam, you can use more than three filters in your filter pack. When you change the filter pack, you can calculate exposure adjustments from the filter factors for the filters you add or remove.

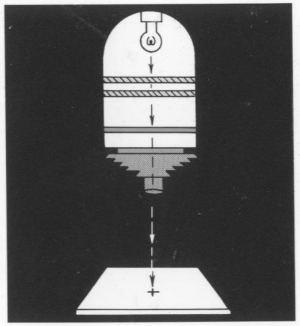
Color printing filters are available in four densities (05, 10, 20, and 40) in cyan, magenta, yellow, and red.

Dichroic Filters—These non-fading filters are built into the lamp housing of color-head enlargers. With dichroic filters, you don't have to use filter factors to calculate exposure changes or take into account the number of filter surfaces. However, *color-density* changes can make it necessary to change the exposure, especially when you make large changes in the filter settings. The characteristics of individual dichroic-filter sets vary, so it's impossible to establish filter factors that will work with all filter systems.

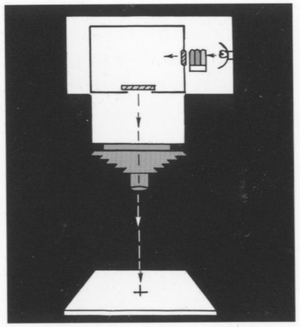
Only magenta, yellow, and cyan filtration is necessary to obtain excellent results with dichroic filters, and cyan corrections are seldom required. Because the filters are adjustable in increments of 0.01 color density unit over an extremely wide range, dichroic filters are very versatile.



CC filters go below the lens (in the image-forming beam) or above the lens, between the lamp and negative.



CP filters go in the lamphouse, between the lamp and negative.



Dichroic filters are built into the lamphouse.

Kodak Wratten Gelatin Filter No. 2B or Kodak Color Printing Filter No. CP2B—You should have one of these filters installed in your enlarger between the lamp and the lens to absorb ultraviolet radiation. (Color-head enlargers have built-in ultraviolet absorbers.)

Viewing Filters—The *Kodak Color Print Viewing Filter Kit,* Publication R-25, will help you evaluate the color balance of your test prints and determine what filter changes to make for proper color balance.

Safelight Filters—We recommend that you handle the following in total darkness: Kodak Ektacolor Portra II, Supra II, and Ultra II Papers; Duraflex RA Print Material; Duratrans RA Display Material; and Duraclear RA Display Material. *If absolutely necessary,* you can use a suitable safelight equipped with a Kodak 13 Safelight Filter and a 7½-watt bulb at least 4 feet (1.2 metres) from the paper or material. Always keep exposure to the safelight as short as possible, especially after the printing exposure.

Handle Kodak Ektachrome Radiance Papers; Kodak Vericolor Slide, Print, and Internegative Films; and Kodak Ektachrome Duplicating Films **in total darkness.**

Exposure Aids

Enlarging Dial—The Enlarging Dial on page 49 provides an easy way to calculate new exposure times for changes in image magnification, enlarger lens aperture, and filter packs.

Enlarging Meters—You can also calculate exposure times for making enlargements by using an enlarging meter. Several types of enlarging meters are available from your photo dealer.

***Kodak Gray Cards,* Publication R-27**—You can use a Kodak Gray Card to produce your own standard negative for calibrating your printing system. (It's also extremely useful for determining film exposure under a variety of conditions.)

Enlarger Timer—A good timer is critical for making accurate and repeatable exposures, especially when you make many prints from one negative. Simple electrical and more elaborate and accurate electronic interval timers are available for controlling exposure times. Electrical timers are usually calibrated in seconds; electronic timers can control exposures to within 1/10 second.

Focus Magnifiers

For critical sharpness in enlargements, you should use a focus magnifier, which focuses on the actual grain in the original. Focus magnifiers consist of a microscope with a mirror mounted on it. Simpler focusing aids are also available.

Other Aids

Camel's-Hair Brush—A flat camel's-hair brush is often all you need to remove dust and lint from negatives or transparencies. The Kodak Camel's-Hair Brush is available in 1- and 2-inch widths.

Anti-Static Brushes—In addition to brushing off dust and lint, these brushes provide a negative charge to repel new dust accumulation.

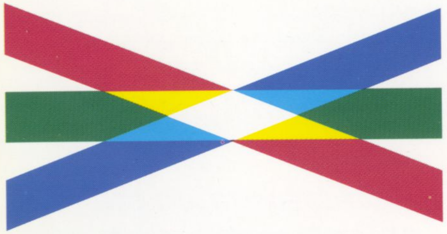
Compressed Air—Cans of air in various sizes are available for blowing dust from negatives and transparencies.

PROCESSING EQUIPMENT

- **Trays, baskets, or tube processor** (Your selection will depend on the volume of materials you process and your personal preference.)
- **Photo thermometer** accurate to within ±0.5°F (±0.3°C)
- **Mixing and storage containers** for processing chemicals
- **Stirring paddle** for mixing chemicals
- **Darkroom graduate** for measuring and pouring chemicals
- **Glass beakers** for holding the processing solutions until they reach the correct temperature (in tube processing)
- **Rubber gloves** to protect your hands from chemicals
- **Darkroom apron** to protect your clothes from chemical spills and splashes
- **Darkroom timer or clock** (digital or with sweep-second hand)
- **Electrical drum agitator** for automatic agitation of tube processors

FILTERS FOR COLOR PRINTING

When red, green, and blue light are mixed in approximately equal amounts, they form white light, as shown by the illustration below. These colors are known as *additive primary colors.* All light consists of mixtures of these three colors. By absorbing the red, green, and blue light, color film is able to record the image of an original scene.



The three colors produced by mixing pairs of the additive primaries are blue-green (cyan), blue-red (magenta), and green-red (yellow). These are called subtractive primary colors (or complementary colors). Each of these colors represents white light minus one of the additive primaries. Cyan is complementary to red, magenta is complementary to green, and yellow is complementary to blue. Note in the illustration that where two additive primary colors overlap, a subtractive (complementary) primary color is formed.

The subtractive primary colors are effectively the negatives of their additive primary colors; you can think of them as controllers of light. A cyan filter permits green and blue light to pass through it, and subtracts red light; a magenta filter permits red and blue to pass through, and blocks green; and a yellow filter permits red and green to pass through, and stops blue light. The amount of light transmitted or blocked by a filter depends on its density. The use of these three filters to control exposure is the basis of subtractive color printing.

Except in large-scale photofinishing, most color printing is done with subtractive filters to produce the primary colors in the finished print. Additive printing with primary colors usually requires very brief individual exposures through primary filters.* This is difficult without automated equipment, and makes procedures such as dodging and burning-in almost impossible—especially when you need to make a number of identical prints from a single negative. However, in subtractive printing, you make a single, longer exposure that allows time for dodging and burning-in.

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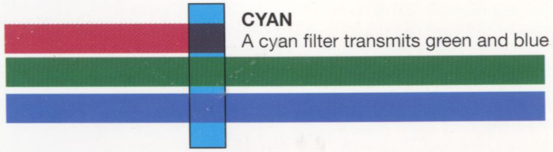
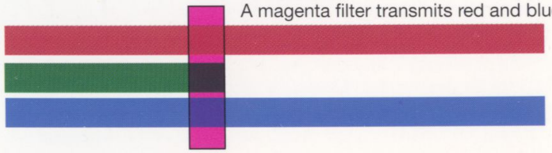
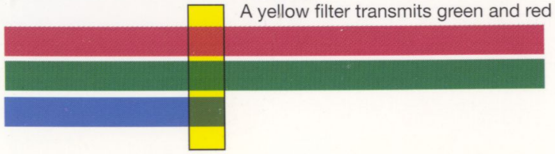
*Enlargers with color heads equipped with dichroic filters in the primary colors for additive printing are now available. However, these enlargers are very expensive, and not many are used by advanced amateurs and small-volume labs.



CYAN
A cyan filter transmits green and blue light and blocks red light.



MAGENTA
A magenta filter transmits red and blue light and blocks green.



YELLOW
A yellow filter transmits green and red light and blocks blue.

Filters are designated by filter type (CC or CP), density, and color. A filter with a density of 0.20 is identified by the number 20; cyan, magenta, and yellow become C, M, and Y. So a filter pack with 20C, 30M, and 40Y filters is actually 0.20 cyan, 0.30 magenta, and 0.40 yellow.

A combination of subtractive primary filters in all three colors produces neutral density. Since neutral density reduces the intensity of the light without providing any color correction, you should remove it. Subtracting an equal amount of each color reduces the neutral density by an equal amount. For example, if you have a filter pack of 20C + 40M + 80Y, you can reduce 0.20 neutral density by removing 20C, 20M, and 20Y from the pack. The filter pack would then be 20M + 60Y. The total density would be lower, and you would be able to stop down the lens or shorten the exposure time.

Keeping the number of filters to a minimum is important primarily when you use CC filters below the lens. Too many filters can adversely affect print definition, so you should use no more than three.

Note that when you separate primary colors into their equivalent subtractive colors, the values of the subtractive colors remain the same. For example, 10R becomes 10M + 10Y; 10G becomes 10C + 10Y; and 10B becomes 10C + 10M. The reverse is also true; for example, 20C + 20Y = 20G. However, when you add or subtract filters of the same color, you add or subtract the densities normally; for example,

10M + 20M = 30M, 40Y – 10Y = 30Y, etc.

KODAK PAPERS, MATERIALS, AND FILMS FOR PRINTING COLOR NEGATIVES

Kodak Paper, Material, or Film	Description	Available Surfaces
Ektacolor Portra II, Supra II, and Ultra II	Fast, resin-coated papers for making color prints from color negatives or internegatives. Process in Kodak Ektacolor RA Chemicals.	E, F, N
Duraflex RA Print	A tough, durable material for making reflection prints. Its characteristics are similar to those of Ektacolor Ultra II Paper, but it is coated on a durable 9-mil thick-base polyester material. Process in Kodak Ektacolor RA Chemicals.	F
Duratrans RA Display	A durable, translucent material on 7-mil Estar Thick Base for making backlit display transparencies. Ideal when durability and good splicing characteristics are important. Process in Kodak Ektacolor RA Chemicals.	—
Duraclear RA Display	A clear-base material suitable for making large display transparencies from color negatives or internegatives. Process in Kodak Ektacolor RA Chemicals.	—
Vericolor Slide SO-279	A 35 mm film for producing slides from color negatives and internegatives by direct printing. Also excellent for making reverse-text slides. Process in Kodak Flexicolor Chemicals.	—
Vericolor Print	Color film for producing transparencies from color negatives and internegatives for display or photomechanical reproduction. Coated on 7-mil Estar Thick Base. Process in Kodak Flexicolor Chemicals.	—

Storage of Unprocessed Kodak Papers and Print Materials

High temperature or humidity can produce unwanted changes in photographic materials. Keep unexposed paper, print and transparency materials, and laboratory films in a refrigerator at 55°F (13°C) or lower in the original sealed box.

To avoid moisture condensation on materials that have been refrigerated, allow them to warm up to room temperature before you open the sealed package. *For best results, remove the materials from cold storage the day before you use them.* If this isn't possible, allow paper to warm up for 2 hours and film for 3 hours, from a storage temperature of 55°F (13°C) or less.

PRINTING COLOR NEGATIVES

Making Prints on Kodak Ektacolor Portra II, Supra II, and Ultra II Papers

If you have never made prints before, select a typical color negative that's been carefully printed by a lab or photofinisher so that you have a good print for comparison. Or you can use a standard negative (available from Kodak) to determine a good starting filter pack for all negatives on the same type of film. (You can make your own standard negatives for different films and typical scenes or subjects. See *Basic Developing, Printing, Enlarging in Color,* Publication AE-13, for more information.)

Use the starting filter pack recommended for the paper you are using, and make a test print. Make exposure and color-balance adjustments, and reprint the negative until you have good density and color balance. Then make a record of the filter pack you used to make the best print. This will be your starting filter pack for printing other similar negatives. If you decide to print the negative at a different degree of enlargement, you will need to adjust the exposure, but not the filter pack.

Enlarger—If possible, use an enlarger designed for making color prints. You can use a black-and-white enlarger if it's equipped with a heat-absorbing glass, a tungsten lamp (such as a Photo Enlarger Lamp No. 212 or 302), and a Kodak Wratten Filter No. 2B or a Kodak Color Printing Filter CP2B between the lamp and the negative carrier to absorb ultraviolet radiation.

Safelight—See "Safelight Filters," page 34.

Filters—You don't need individual color-correction filters if your color enlarger has built-in dichroic filters. If you use color-correction filters, use Kodak Color Compensating (CC) Filters if the filter holder is in the light path between the negative and the paper. Use either Kodak Color Compensating Filters or Kodak Color Printing (CP) Filters if you place them between the enlarger lamp and the negative carrier. The following table lists the CC or CP filters you will need for color printing.

Filters for Printing Color Negatives (With Red No. 2B or CP2B installed above negative)

Color Compensating (CC) Filters			Color Printing (CP) Filters			
Magenta	Yellow	Red	Magenta	Yellow	Red	Cyan
—	—	—	—	—	—	CP025C-2[†]
CC05M	CC05Y	CC05R[*]	CP05M	CP05Y	—	CP05C-2[†]
CC10M	CC10Y	CC10R[*]	CP10M	CP10Y	—	CP10C-2[†]
CC20M	CC20Y	CC20R[*]	CP20M	CP20Y	—	—
CC30M	CC30Y	CC30R[*]	—	—	CP30R[*]	—
CC40M	CC40Y	CC40R[*]	CP40M	CP40Y	CP40R[*]	—
CC50M	CC50Y	CC50R[*]	—	—	—	—

[*] You can use a red filter to replace the equivalent value in magenta and yellow. For example, a 30R filter will replace 30M + 30Y. This is especially helpful if you are using CC filters below the lens and can use no more than three filters.

[†] Occasionally, you may need cyan filtration. If so, use filters with the suffix "-2." Filters without the "-2" may not absorb enough infrared radiation.

Making Test Strips, Test Prints, and Final Prints—You can save time and materials in determining exposure and filtration by printing your first test print as a test strip. To make a test strip:

1. Start with a filter pack of 40M + 50Y or the filter pack you determined for a typical negative by following the procedure on page 37.
2. Put the negative into the negative carrier with the emulsion side (dull side) down; clean off any dust or lint with a negative brush or compressed air.
3. Insert the negative carrier into the enlarger, and size, compose, and focus the image with the enlarger on and the lens wide open. (Place a piece of scrap photographic paper on the easel for focusing.)
4. Close down the lens aperture 1 or 2 stops.
5. Remove the paper that you used for focusing. Turn off the enlarger, and put a sheet of enlarging paper in the easel. Using a piece of cardboard, cover all but one fourth of the paper and make a 5-second* exposure. Uncover another fourth of the paper and make another 5-second exposure. Repeat this procedure until you have exposed the whole sheet of paper. This will provide you with areas exposed for 5,10,15, and 20 seconds.
6. Process the paper (see page 46 for processing instructions). Squeegee any excess water from both sides of the paper, and place it on a flat surface to dry at room temperature, or use a print dryer or a portable hair dryer for faster drying. With a hair dryer, use a low heat setting and a high blower setting. (Keep a portable hair dryer moving and far enough from the print to prevent damage from excessive heat.) The color of the print will change as it dries; that is why you can't properly evaluate a wet print.
7. Evaluate exposure under the same type of illumination that will be used to display or view the print. Most home lighting is incandescent or tungsten; most industrial and office lighting is fluorescent. Determine the exposure time that produced the best density.
8. Make a test print at the time that produced the best density. Process the print and evaluate the color balance as described on page 39. Adjust the filtration, and repeat the procedure until you have the correct density and color balance. You can then use the final filter pack as a starting point for printing other negatives from the same kind of film.

Proof Sheets—After you have determined a good filter pack and exposure time for your prints, you may want to make proof prints from each roll of film. Proof sheets are simply contact prints of your negatives. You can use them to determine, with a minimum of work and expense, which negatives have the best exposure, lighting, and composition for enlarging. A proof sheet of your negatives along with your standard negative will show you which negatives you can print with similar filtration.

Use any contact-printing frame (available from photo dealers) to hold the negatives and paper in contact for exposure. An 8 x 10-inch or larger frame will let you proof one or more rolls at a time.

Put your negatives and enlarging paper in the frame with the emulsion sides facing each other and the base side of the negatives toward the glass. Fasten the cover of the frame, and center the frame on your easel with the glass facing the enlarger light source. (With some contact-printing frames, you can position the negatives in room light before laying the paper over them. With others, you must position the paper first, so you will have to work under a safelight or in total darkness.) Use the same filtration, exposure time, aperture, and enlarger-to-easel distance that you used for making your final print. Expose and process your proof sheets.

Record the exposure data (filtration, aperture, exposure time, and lens-to-easel distance) on the back of each proof sheet after it has dried. File your proof sheets with your negatives as a convenient reference.

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*The number of exposures and the time interval you use are optional. Use whatever increments provide enough information for you to judge the best exposure. Exposure times vary considerably with the distance from the lens to the easel (degree of enlargement) and the density of the negative.

Evaluating and Correcting Color Balance—You can evaluate the color balance of your prints in several ways:

- View your prints through the filters in the *KODAK Color Print Viewing Filter Kit,* Publication R-25, and follow the instructions for making corrections.
- Compare your results with the ringaround on pages 40–41 and make the recommended corrections.
- Decide the overall color balance. See the table below for recommended corrections.
- Use a photometer or densitometer.

***KODAK Color Print Viewing Filter Kit*—**This kit consists of six viewing-filter cards and instructions. Each card contains filters of one of six colors—red, green, blue, cyan, magenta, and yellow—with 10, 20, and 40 density values. To determine filtration changes, view the print through the filters and determine which filter (or combination of filters) makes the color balance look best; then make the filter changes printed on the card below the filter. The kit includes a color-relationship wheel and a filter-factor table for calculating exposure times. If the color balance is off by more than 0.40 density, you may need to make more than one test print to obtain the best color balance.

One side of the filter cards gives recommended corrections for prints from color negatives; the other side gives corrections for prints from color transparencies or slides.

Evaluating Prints by Using a Ringaround—The ringaround on pages 40–41 provides an easy and effective way of determining the corrections needed to obtain good color balance. Compare your print with the photos in the ringaround, and find the one that most closely resembles your print; adjust the filtration as indicated below the photo, and make a new print.

Using the Table After a Visual Check—The table below gives filtration adjustments for correcting color balance. If you are a good judge of color, this table may be easier to use than the ringaround. First decide the color balance and the degree of correction needed; then see the table for the filtration changes.

Using a Photometer or Densitometer—Photometers and densitometers are available for on- or off-easel use and for spot or large-area evaluation of negatives and transparencies. Some units provide direct filter recommendations and others require interpretation and calculations to determine the best filtration. Off-easel readings may be made directly from the negative or a standard negative or transparency. On-easel evaluations are usually made by direct readings. As mentioned earlier, some enlargers have built-in photometers. This equipment is usually expensive, and is used primarily by large-volume photofinishers because it provides good-quality prints with a minimum of reprinting. If you're interested in such equipment, see a photo supplier for information and recommendations.

Filtration Adjustments

If the Overall Color Balance Is Too	Amount of Change Needed			
	Very Slight	Slight	Moderate	Considerable
Red	+ 05M + 05Y	+ 10M + 10Y	+ 20M + 20Y	+ 30M + 30Y
Green	– 05M	– 10M	– 20M	– 30M
Blue	– 05Y	– 10Y	– 20Y	– 30Y
Cyan	– 05M – 05Y	– 10M – 10Y	– 20M – 20Y	– 30M – 30Y
Magenta	+ 05M	+ 10M	+ 20M	+ 30M
Yellow	+ 05Y	+ 10Y	+ 20Y	+ 30Y

Printing Color Negatives on Other Kodak Materials

Kodak Duraflex RA Print Material, Kodak Duratrans RA Display Material, and Kodak Duraclear RA Display Material—Use these materials to produce brilliant display transparencies and prints from color negatives or internegatives. They are available in a variety of sheet and roll sizes for advertising, promotional, and decorative uses, and applications that call for great durability. They are designed for rapid-access processing.

The characteristics, and equipment and safelight requirements are the same as those for Kodak Ektacolor Portra II, Supra II, and Ultra II Papers. Follow the procedures on page 37 to make color prints on these materials.

To make a test print, start with the appropriate filtration listed below.

Material	Starting Filtration for Test Print
Duraclear RA Display	40M + 10Y
Duratrans RA Display	40M + 25Y
Duraflex RA Print	40M + 30Y

For more information, see the instructions packaged with the material or Kodak Publication No. E-143, *Kodak Display and Print Materials for Process RA-4,* and No. E-84, *Backlit Displays with Kodak Materials.*

Kodak Vericolor Slide Film—This film is intended for producing positive transparencies from color negatives or internegatives by direct printing. You can also use it to make reverse-text slides. It is available in 35 mm x 100-foot rolls (code 5072) and 135-36 magazines (SO-279), and can be mounted as slides or used uncut as filmstrips.

Handle this film only in total darkness. Expose it with equipment that has a tungsten-halogen light source (3200 K) and built-in dichroic filters, a heat-absorbing glass, and a No. 2B or CP2B filter. The film is intended for exposure times from ¼ second to 8 seconds.

Process Kodak Vericolor Slide Film in Kodak Flexicolor Chemicals.

Use the filtration in the table below as starting points.

Filtration for Printing Negatives on Kodak Vericolor Slide Film

To Print Negatives from This Kodak Film	Use This Starting Filtration
Gold 100, 200, 400	20M + 30Y
Ektar 25 Professional, Royal Gold 25, 100, 200, 400, 1000	
Ektapress Plus 100, 200, 400, 1600*	
Pro 100, 400, 400 MC	
Vericolor III Professional	20M + 35Y
Vericolor II Professional, Type L	20M + 25Y

*For push-processed films, you may need to adjust the filtration.

Notes: Filter recommendations are for negatives made on daylight films exposed with daylight or electronic-flash illumination, or for tungsten film exposed with tungsten light. Negatives made on daylight film under tungsten light will require more yellow filtration.

Although we recommend tungsten-halogen illumination and dichroic filters for exposing Vericolor Slide Film, other light sources *except fluorescent* with CC or CP filters are acceptable.

Kodak Vericolor Print Film—This film is intended for making positive transparencies from color negatives or internegatives for displays or photomechanical reproduction.

It is available in sheets from 4 x 5 to 20 x 24 inches and in wide rolls (40 and 50 inches x 100 feet).

Handle unexposed film in total darkness. Use the filtration, equipment, and illumination recommended for Kodak Vericolor Slide Film.

Process this film in Kodak Flexicolor Chemicals.

For more information on Kodak Vericolor Slide and Print Films, see the instruction sheets packed with the films.

Making Duplicate Color Negatives on Kodak Ektachrome Duplicating Films

Kodak Ektachrome Duplicating Films are intended primarily for making duplicate slides or transparencies, but you can also use them for making duplicate color negatives and for copying prints. You can expose these films with a contact printer, an enlarger, or a 35 mm single-lens reflex camera with a slide-duplicating attachment. Process these films in Process E-6 chemicals (see page 25).

Four types of Ektachrome Duplicating Films are available for different uses with different light sources. Type 5071 film is available in 135-36 magazines and 35 mm, 46 mm and 70 mm long rolls for use with tungsten (3200 K) illumination. Type 6121 film is available in sheets from 4 x 5 inches to 16 x 20 inches for use with tungsten illumination. Kodak Ektachrome SE Duplicating Film SO-366 is available in 135-36 magazines and 35 mm long rolls for exposure with electronic flash. Type 7121 film is available in 4 x 5- and 8 x 10-inch sizes. It is designed for duplicating originals on Kodachrome Films.

Handle unprocessed film in total darkness. During processing, you can turn on room lights after the reversal-bath step.

Use the basic filtration provided with the film. Then make the filtration and exposure adjustments recommended in the following table for the type of film you are duplicating. These adjustments allow for the color of the mask used in each negative film, and place the image on the straight-line portion of the characteristic curve of the duplicating film.

For more information, see *Kodak Ektachrome Duplicating Films (Process E-6),* Kodak Publication No. E-38.

Suggested Filter and Exposure Adjustments* for Copying Color Negatives

Kodak Color Negative Film	CC Filter	Exposure Adjustment
Vericolor Professional	+30C	+½ stop
Kodak Gold, VR, VR-G and II		
Royal Gold; Ektar; Ektapress Gold Professional		
Kodacolor-X	+80C + 20M	+2 stops

*These recommendations are starting points. You may need to make additional filter and exposure adjustments.

Making Black-and-White Prints from Color Negatives

Kodak Panalure Select RC Paper is designed for making black-and-white enlargements (or contact prints with reduced illumination) from color negatives.

This paper comes in three contrast grades to accommodate the large variety of color negative films available today. The L grade is designed for printing negatives of high contrast, and is especially useful in portrait and school photography. The M grade, for printing negatives of average contrast, is useful in portraiture, photojournalism, and commercial and industrial photography. The H grade, for printing negatives of low contrast, is particularly useful for the photojournalist.

Paper Speed

Contrast Grade	L	M	H
ISO Paper Speed	1000	800	500

Enlarging and processing procedures are the same as those for other Kodak black-and-white single-contrast papers. For critical applications, use a Kodak 13 Safelight Filter (amber) in a suitable safelight lamp with a bulb of 7½ watts or less at least 4 feet (1.2 metres) from the paper. Minimize safelight exposure to avoid unwanted quality changes. Excessive safelight exposure will lower paper contrast or affect gray-tone reproduction of colors before creating significant fog density. **Be especially careful** if you use other types of safelights.

For more information, see the instruction sheet or the *Kodak Black-and-White Darkroom Dataguide,* Publication R-20.

Professional labs can also use Kodak Ektamax Professional Papers for making repro-grade black-and-white prints from color negatives. Designed for processing in Kodak Ektacolor RA Chemicals for Process RA-4, these papers can be printed with the same equipment as Ektacolor Portra II and Supra II Papers. See Kodak Publication No. G-22, *Kodak Ektamax RA Professional Papers,* for more information.